5.3 Management of Other DWSP Lands

DWSP staff manages the non-forested DWSP-controlled lands in the Quabbin Reservoir's watershed system on a case-by-case basis. Presently, four non-forested areas are exceptions within the Land Management Program. These areas are non-forested lands that: 1) fall within administration areas; 2) are dedicated to the limited fishing program; 3) serve as viewsheds; or 4) are outside of the watershed itself (some parts of Quabbin Park including Quabbin Cemetery). Collectively these areas are managed in the context of the drinking water supply's watershed, but unique attributes require tailored land management approaches. The management of these other DWSP lands is briefly discussed below.

Highlights of Management of Other DWSP Lands:

1. Grounds around administration areas and the fishing areas are maintained to meet recreation and aesthetic objectives, while also addressing water supply protection issues.
2. Open lands include fields, powerline rights-of-way, gravel pits, and others total about 1,000 acres at Quabbin and are maintained for a variety of purposes.
3. 5 high use viewsheds are kept open to allow exceptional vantage points from which to view the watershed.
4. Areas within the Quabbin Park that are maintained for recreation or public access include the Visitor Center, Winsor Dam, Hank's Meadow and Goodnough Dike picnic areas, and the Quabbin Park Cemetery.
5. Access roads are critical to the security and management of the watershed lands and associated structures. Roads are categorized by width, surface material, drainage characteristics, and hydrologic sensitivity. CMPs for road maintenance and the process for spill response are detailed, as well as the internal review process for roadwork and gravel extraction.

5.3.1 Grounds around Administration Areas

The DWSP Administrative Areas are located near the Winsor Dam in Belchertown, MA. The area includes the grounds around the main Administration Building which holds the Quabbin Visitor's Center, the MA State Police Barracks, the hangar/boat launch, and staff offices. In addition, behind the Administration Building, there are garages for vehicles and engine repair and the Stewardship Forest. Nearby, in the area of the Emergency Overflow near Bluemeadow Road there are several houses serving as offices for forestry and natural resources staff and watershed rangers. Equipment and material storage is located in these restricted use areas. This area includes a large, visitor parking area typically used by cars, but also by tour buses on a seasonal basis.

5.3.2 Boat Launch Areas 1, 2 & 3

Boat Launch Area 3

Boat launch areas 1, 2 & 3 are high use recreational areas within DWSP lands in the Quabbin Reservoir Watershed system. The number of visitors to these areas is recorded; **Table 50** shows the numbers for the 2006 fishing season, when the areas were open 5 days per week. DWSP manages these areas to reduce the risks from sanitation facilities, gas and oil, aquatic plants, non-point source pollution (from vehicle parking and boat launching), and hazardous material storage (e.g., fuel for boats). Monitoring and rule enforcement is conducted by Watershed Rangers and the fishing area attendants with support from the Massachusetts State Police and Massachusetts Environmental Police Officers. DWSP staff use the Watershed Protection Regulations, 350 CMR 11.00 as well as the Division's Public Access Management Plan to guide specific management decisions in these areas.

Table 50: Boat Launch Areas - Recorded Visitors during 2006 Season

Visitor Type	Area 1 (Gate 8)	Area 2 (Gate 31)	Area 3 (Gate 43)	Totals
Shore Fishing	1,382	547	979	2,908
Private Boats	4,270	5,859	6,073	16,202
DCR Rental Boats	2,952	2,291	2,972	8,215
Fishing Licenses Sold	764	663	725	2,152

5.3.3 Maintained Open Land

Approximately 1,000 acres of open land has been created and maintained within the Division's holdings at Quabbin, either as part of an historic cultural landscape (Dana Common or Prescott Center), as openings surrounding administration areas (around buildings, Winsor Dam, Goodnough Dike, Quabbin Tower, and Hank's Meadow in Quabbin Park; around Shaft 12; fishing areas, etc.) or for wildlife habitat (open fields in Gates 12, 17, 20, 29, 45). The most recent comprehensive forest typing identified the open areas and acreages shown in **Table 51.** These areas are maintained through regular mowing or less frequent brush-mowing and/or prescribed fire.

Table 51: Maintained Open Lands at Quabbin

Type	Description	Acres
Abandoned orchard	Areas with planted fruit trees that persist despite competition, some of which are actively maintained for wildlife or ornamental purposes	8
Grass or herb cover	Land that is maintained in grasses or herbaceous cover but not associated with administrative areas	311
Upland brush	Recently abandoned fields in a wide mix of mostly brushy cover; some are maintained via occasional mowing	111
Power lines	These areas are kept open by power companies and other utilities and serve incidentally as wildlife habitat	289
Administration areas	This category includes the footprint of buildings, parking lots, and other structures, as well as mowed fields and grounds surrounding these	154
Lawns, ornamental plantings	Areas around administrative buildings within Quabbin Park, on and adjacent to dams and dikes. Dominated by mowed grass and ornamental plantings	88
Gravel pits	Areas from which gravel is currently or has been historically extracted and are not currently forested	17
TOTAL		**978**

Enfield lookout

5.3.4 Viewsheds

A viewshed is an area of land, water, or combined landscape that is visible from a fixed vantage point. The term is used widely in urban planning, archaeology, and military science. In DWSP's land management context, viewsheds are vantage points of particular scenic or historic value in the watershed that are deemed worthy of preservation. The preservation and creation of viewsheds is a secondary goal in DWSP's land management decisions and requires both forest harvesting decisions (to maintain the view) and the designation and maintenance of open space areas.

Examples of DWSP viewsheds within the Quabbin Reservoir watershed system include:

- Pelham Lookout - magnificent view of the west arm of the reservoir and Prescott Peninsula.
- New Salem Lookout - magnificent view of the north end of the reservoir and forested lands.
- Enfield Lookout - magnificent view of the reservoir's west and east arms.
- Quabbin Hill Lookout Tower – view of Mount Greylock and New Hampshire on a clear day.
- Frank E. Winsor Memorial Lookout – direct view of the Winsor Dam.

5.3.5 Quabbin Park Recreation Areas

Quabbin Park (which includes the 82 acre Quabbin Cemetery) is approximately 3,000 acres in size. The Park represents nearly 4% of the DWSP owned land in the Quabbin Reservoir Watershed system. Estimates suggest that over 80% of the recreational use in the system occurs in this 4% of the system, half of which is off the watershed. One half of the Park is located on watershed lands, and the other half, primarily the cemetery, is located on off-watershed lands.

There are many areas within the Park used by the public for passive and active recreation access, including:

- Quabbin Visitor's Center (and restrooms) located in the Administration Building.
- Winsor Dam located near the Administration building used for walking and biking. Since September 11, 2001, the Winsor Dam has been closed to general vehicle access.
- Y-Pool (Seasonal Portable Toilet) located off-watershed used for fly-fishing.
- Winsor Memorial used for bird watching, sightseeing, and picnicking.
- Quabbin Hill Lookout Tower (Restrooms and Portable Toilets) used for sightseeing, bird watching, and picnicking.
- Enfield Lookout (Portable Toilet) birding, walking, and picnicking.
- Hank's Meadow/Picnic area (seasonal Portable Toilet) used for bird watching, hiking, and picnicking.
- Goodnough Dike/Picnic area (seasonal Portable Toilet) used for walking, biking, bird watching, and picnicking.
- Quabbin Park Cemetery is approximately 82 acres in size. It contains over 6,000 graves that were relocated from the towns of Greenwich, Prescott, Dana, and Enfield.

5.3.6 Access Roads

DWSP Quabbin watershed lands include a woods road system of approximately 200-225 miles that provides vehicle access throughout most of the watershed area (some roads are being closed and allowed to return to forest cover; some occur within power line rights-of-way). The majority of these roads date to the pre-reservoir communities that were settled in this area. Some of these were well-constructed, well-drained roads that have been maintained by DWSP to varying degrees depending on priority for their usage. Others were created as simple cart paths and have since evolved to carry heavier traffic, but may not have been well-designed or placed for that purpose. At an average width of ten feet, the 200+ miles of Quabbin woods roads cover an estimated 242 acres of DWSP lands on the Quabbin watershed.

The Quabbin woods road system is essential in order to gain access for key watershed management activities including fire protection, forest management, and police patrols. The interface between roads and water resources is frequently the most likely source of water supply degradation on an otherwise stable, forested watershed. The proper maintenance of woods roads controls the deposition of sediment and organic matter into nearby tributaries, and is among the most critical land management practices conducted by the Division.

5.3.6.1 Road Categories

Quabbin's woods roads have been categorized into four types, listed in **Table 52**.

Table 52: Road Categories in the Quabbin Reservoir Watershed

Type	Road Width	Road Surface	Drainage	Maintenance Considerations	Example
Type 1: All Weather Gravel or Asphalt Roads	12 ft.-24 ft	Processed gravel or pavement	System adequate to protect roadway in most climatic conditions (50 year storm)	Type 1 roads that have a pavement surface will be swept clear of the build up of organic materials every five years. Type 1 gravel roadways will be graded annually with a road grader. Ditches and culverts will be cleared and culverts replaced as necessary. Roadside brush will be mowed yearly.	Pavement – Gate 40 road to Dana; Gravel – Gate 20 road to Lily Pond
Type 2: Secondary Gravel Roads	10 ft. - 12ft.	Processed gravel or bank run gravel	System adequate to protect roadway throughout most of the year. Most Type 2 roads will be closed during the spring mud season.	Type 2 Roads will be graded annually with a road grader. Ditches and culverts will be cleaned and kept free of debris and culverts will be replaced as necessary. Roadside brush will be mowed a minimum of once every three years	Governor's Woods Road from Gate 8 to Reservoir.
Type 3: Intermittent-use Roadways	8 ft.-12 ft.	Gravel or grass covered	System inadequate for use except when conditions are very dry.	Many of these are dead-end access roads not more than 1/2 mile in length. These roads will be mowed every three years to keep them open. Any culverts that are present, particularly at brook crossings, are inspected and maintained as necessary. Some of these roadways are situated on hillsides with a greater than 10 degree slope. Special consideration must be exercised to protect the vegetative cover and to maintain culverts and water bars on these slopes.	Gates 24 and 25 to the intersection of Gate 22 road
Type 4: Forwarder Roads	8 ft.-12ft.	Vegetative cover, impassable in all seasons except by specialized machinery	Temporary drainage systems may be used. Waterbars are used to control erosion on slopes	These dead end access roads are used only on a frequency of every five to forty years. These roadways are only used during the actual operation of timber sales; when the particular sale is finished the roadway will be stabilized to prevent overland erosion.	

A Special Category is designated for Tractor Trailer Access Roads. These roads generally include all Type 1 Roads, many of the Type 2 Roads, and some of the Type 3 Roads. They are usable by heavy equipment such as tractor trailers, which are the key design vehicle (wheel base of 50 feet chosen for design). Special considerations must be given to the maneuverability of the trailers accessing these roads; trucks must have the ability to turn around or seek other means of egress, to gain traction on steep grades, and to maneuver curves within the vehicle's tracking limits. These roads typically serve as a principal access point for very large blocks of land and therefore must be designed to accommodate a concentrated and higher volume of truck traffic with heavier loads than might be expected of roads designed for standard tri-axle logging trucks accessing smaller areas.

Examples of a Tractor Trailer Access Road include Gate 17, used to access Prescott Peninsula, and East Street from Gate 49 to the truck turnaround located on the Hardwick shoreline. The following minimum design standards shall apply to roads identified to serve as principal collectors of tractor trailer traffic.

Travel Lane Width:	11'6"
Drainage:	Crowned with ditches and relief culverts
Road Surface:	12 inches of processed gravel
Grade Limitations:	Up to 12%
Curve Radius:	41 feet (centerline)*
Curve Widening:	27 feet for 90° deflection*
Turnaround:	80 ft wide by 50 ft deep
Winter Maintenance:	Plowing/sanding specs required as part of logging permit

DWSP recognizes that the differences between standard tri-axle logging trucks and trailers may extend beyond simple physical dimensions. As tractor trailer loads are frequently 'back-hauls' of logs by French Canadian drivers, their may be language barriers as well as a lack of familiarity with the Quabbin woods road system. The Division is beginning attempts to reduce these differences through improved road signage, including identification of critical resources areas like stream crossings and the inclusion of additional site access maps in timber harvesting permits. An improved knowledge of the road system will serve to improve traffic safety and spill response capabilities.

The amount of maintenance needed on each type of roadway is difficult to predict, but is dependent on the response to weather conditions, the seasonal stability of the road, and the level of use. Site characteristics such as topography, landscape position, or proximity to wetlands also factor into maintenance requirements. The work needed to keep all major roads open throughout the year is largely dependent on the weather, and the ability to complete this work is largely dependent on the availability of labor and equipment. Major storm events affect roadways as trees or limbs fall into the roadway making them impassable. Crews are dispatched after major storm events to clear roads of fallen debris. Washouts due to culvert failure or clogged drainage ditches occasionally occur after major storms, although the Division is working to inventory and replace culverts that are undersized or have deteriorated.

DWSP is in the process of identifying specific sections of roads that will need grading work, such as the addition of bank run and processed gravel, in the next ten years. Other general road maintenance occurring on a regular basis includes annual grading of some heavily-used roads, removal of hazardous roadside trees, roadside mowing (which facilitates drainage and keeps roads open), culvert replacement and the processing and spreading of gravel as needed to maintain access or for specific land management activities.

* AASHTO, 2001. "A Policy on Geometric Design of Highways and Streets"

5.3.6.2 Criteria for Determining Hydrologic Road Sensitivity

Some of the roads the Division inherited at Quabbin were poorly located or poorly designed for handling modern log truck or tractor-trailer traffic. The Division is in the process of assessing these roads to determine which can be upgraded at reasonable expense and which are too costly to upgrade. The latter will not be maintained for truck use; the land areas that they access will either be managed by requiring that the wood be forwarded to better roads or will become inaccessible, non-management areas. The criteria currently under development for making this determination include:

1. **Dead-end roads.** Unless a turn-around of sufficient size can be developed without presenting unacceptable risk to water supplies, a dead-end road may not be useable. These roads also present challenges in managing spills, as it can be difficult to maneuver spill response equipment to the site. The filling of Quabbin Reservoir created short spur roads that dead-end at the Reservoir; however many of these have good conditions for creating truck turn-a-rounds.

2. **Grades greater than 10-12%.** Roads with grades in excess of 10-12% can present hauling difficulties for fully loaded log trucks or tractor-trailers.

3. **Physical road limitations.** In some cases, the condition of the road surface (e.g., shallow to bedrock), the absence of opportunities to move water off the road surface (for historic roads that were built or have eroded deep below the surrounding land), poor culverts that are excessively expensive to upgrade to handle a 50-year storm event, and other conditions make the road too expensive to recover to useable condition.

4. **Bridges.** If it is not known whether existing bridges are rated to at least 80,000 pounds, they are considered impassable for log trucks or tractor-trailers.

5. **Hydrologic sensitivity.** This criterion includes the hydrologic distance to the nearest intake, the hydrologic distance to the Reservoir, and the hydrologic distance to any water resource (tributaries, wetlands). The Division is still developing specific thresholds for these considerations.

6. **Critical habitats.** An assessment will be made to determine if reconditioning a road would have unacceptable impacts on critical habitats for flora or fauna. In most cases, the road has been a feature on the landscape for a long time, so that upgrading it is unlikely to cause critical additional impact. There are exceptions to this rule, especially where an upgrade would require major modifications or the addition of a turnaround near a critical habitat.

7. **Cultural/historical resource limitations.** Similar to the critical habitats criterion, the necessary road or site work to upgrade the use of the road might cause unacceptable impacts on cultural resources that have been identified in the area.

5.3.6.3 Regular Review of Access Road Maintenance Needs

The scheduling of road maintenance to coincide with the use of these roads for forest management is a difficult challenge that requires regular communication across several staff groups. Foresters propose silvicultural operations in each of the management blocks on an annual basis based on priorities in the land management plan, current markets for different species and products, and opportunities for improvements in structural diversity and species composition. A component of these proposals is the identification of access needs, which generally include maintenance or upgrades in the haul roads used to remove wood products from the landing to the main highways outside the property and in the landings themselves, in order to accommodate the anticipated equipment and truck traffic. While these proposals give the road maintenance staff an expectation of anticipated work, the scheduling of this work is complicated by the variable time required to complete the marking and selling of the proposed lots and by

the fact that the buyer is allowed to postpone starting a lot for up to two years. Therefore, regular review of priorities for access maintenance and improvement work is necessary.

The Forestry staff holds meetings every 4-8 weeks to review the status of active and pending silvicultural work, markets, changes in regulations, current problems with insects and diseases, and a wide variety of other topics. The Chief Forester will communicate identified current priorities for access work to the maintenance staff following these meetings. In addition, representatives of these two staff groups will conduct meetings in April and August to update the access maintenance priorities. While a variety of variables make it difficult to produce a fixed maintenance schedule, improved, regular communications are designed to better align priorities with availability of maintenance staff and equipment.

5.3.6.4 Pre-Planned Spill Response for Silvicultural Operations

All logging contractors who work on Division properties are licensed Massachusetts Timber Harvesters, with basic training, experience, and a good understanding of the potential threat to water supply represented by the size and weight of their equipment and by the volumes of petroleum products carried on this equipment. Log trucks and tractor-trailers typically carry up to 200 gallons of diesel fuel. Larger mechanized harvesting equipment can carry as much as 150 gallons of hydraulic fluid, as well as diesel fuel. In some situations, the Division allows fuel trucks with much larger capacities to be brought into staging areas to refuel equipment. On operations using hand felling or chainsaw bucking at the landing, chainsaw gas and bar and chain oil will also be on site, though generally in amounts of less than 10 gallons.

The most common type of spill that occurs at harvesting operations is the failure of a hydraulic line on such equipment as feller-buncher-processors or forwarders. While these machines may carry as much as 150 gallons of hydraulic fluid, the failure of one of these high-pressure hoses triggers machine responses designed to prevent high-volume spills, including automatic shutdown of hydraulic pumps or an automatic reversal to pull fluid back into the reservoir. When a spill occurs due to a failed hydraulic line, it typically results in the loss of less than 10 gallons of fluid.

All Timber Harvesting Permits on Division properties require that each piece of logging equipment carry on-board, at all times, sufficient oil-absorbent cloth to catch a ten-gallon spill, providing an immediate response to a leak or a hose failure. In addition, prior to the advertisement of a timber harvesting sale, the Division assesses the area and develops a Spill Response Plan (SRP). Where the lot can be accessed from more than one road, or from both directions on the same road, it is assumed that a spill response could be mobilized quickly from the nearest office (Belchertown or New Salem). However, if it is possible that equipment or trucks could prevent downstream access to a spill (e.g., when the only access road dead-ends at the Reservoir), a box containing oil-absorbent cloths and booms (to stretch across streams or outlets) is placed near the bottom of the access road, as well as a small boat, if required to place an oil-absorbing boom. Finally, a Spill Response Plan is included in the contract for the timber sale, which includes:

1. Locations of all wetlands, streams, culverts, and other water features within the lot.
2. A map showing access to and from the nearest public road, with the location of all wetlands, streams, culverts, intersecting roads, and areas of critical habitat identified.
3. Any limitations placed on the quantity and type of fueling permitted within the lot.
4. The requirement for a pre-harvesting meeting between Division foresters and the logging contractor to review spill response procedures.
5. Locations of permanent and temporary access roads and all staging areas.
6. Locations of spill response boxes, if these are being kept on the lot.
7. A list of phone numbers to call and procedures to follow in the event of a spill.

5.3.6.5 Conservation Management Practices for Road Maintenance

The objectives of forest road maintenance on the watershed are to provide for vehicle access to support key watershed management activities, and to minimize adverse water quality impacts associated with this road system. Activities that are dependent upon a good access road system include fire protection, forest management, and police patrols. These activities require stable, properly shaped and ditched road surfaces with adequate structures to manage storm event runoff. The vast majority of road maintenance on DWSP properties is accomplished by DWSP staff and equipment.

To accomplish these objectives DWSP crews use various mitigating procedures to protect stream water quality during routine maintenance activities. It should be noted that specific sites may require special systems not described here, such as the use of geotextiles, erosion control blankets, subsurface drainage, and rip-rap materials.

- **Shaping Road Surface.** The most basic component of a stable road is proper crowning and ditching, which allow storm runoff to leave the travel surface and be collected in the roadside ditch.

- **Relief Ditches, Relief Culverts, and Waterbars.** The frequent removal of storm water runoff from the roadside ditch is important to limit the amount of soil and gravel that is washed from an area during an event. The spacing of the relief structures is determined by combining site data such as slope of the road, slope of adjacent woodland, soil type and depth, and physical structure of the road. The general rule of thumb is to place relief structures as often as the landscape allows on most slopes. Relief structures, wherever possible, will discharge the storm runoff not less than 50 feet from streams or wetlands.

- **Sediment Traps.** These small basins will be installed where needed as part of road reconstruction activities to reduce the velocity of stormwater and to drop out larger sediments. The traps are formed by excavating a shallow depression or by placing an earthen or stone berm across a low area or swale. The traps are sized based on a target storage volume of 67 cubic yards per each acre of road drainage area. It is recommended that the sediment collected inside of the trap be removed when it has accumulated to one-half the design depth.

- **Dry Season Work.** All road work, except for emergency repair work, some major bridge work (which may extend beyond dry periods), and emergency culvert replacement, will be accomplished during dry periods (primarily summer), when low water flow and stable soil conditions will help mitigate impacts from soil disruption.

- **Use of Silt Fence/Hay Bales.** Wetlands will be protected by properly installed hay bales or industry standard silt fence whenever road maintenance work requires disturbance near these resources.

- **Seeding of Disturbed Areas.** Areas of disturbed soil will be graded and seeded with quick-growing grass species upon completion of road maintenance projects. DWSP has purchased a "hydro-seeder" for this purpose.

- **Special Road Surfaces.** Alternative road surface materials may be appropriate in limiting loss of material through erosion because of the huge variation of historical forest road construction and use. Forest roads that are rarely used may be shaped and seeded with grass. These roads would then be maintained by yearly mowing and culvert cleaning. Depending on location and use, these roads may also be blocked by use of barways to keep out all but essential traffic.

- **Stream Crossings.** It is DWSP's intention to limit catastrophic washouts by replacing under-

sized culverts with structures that will meet standards for a 50-year flood. Both culverts and ditches will be kept open and clear of all restrictions in order to prevent the back up of storm runoff and the resulting washout. In addition, DWSP will continue installation of overflow spill areas (reinforced, low areas on a road adjacent to major streams) capable of spilling the flow from a 100 year flood on major tributaries. Replacement culverts will also be chosen and designed to meet recently revised requirements for the protection of fisheries and other wildlife use of streams. The Division will design replacement stream crossings on fish-bearing, perennial streams and/or where critical habitat has been identified consistent with the fish-passage standards established under the Massachusetts Riverways Program, Massachusetts River and Stream Crossing Standards dated August 6, 2004. It is the DWSP's intent to design replacement stream crossings to the following standards:

- Crossing width should be a minimum of 1.2 times bankfull width.
- Culvert pipes should ideally be embedded to a minimum depth of one foot and a low-flow channel should be shaped within the passage.
- Work should be limited to the period from July 15 to October 1.
- Barriers to fish/aquatic life passage should be eliminated or avoided by:
  - Eliminating inlet/outlet drops
  - Avoiding constriction of flow and/or causing significant turbulence
  - Minimizing tailwater armoring.

5.3.6.6 Internal Review of Proposed Roadwork or Gravel Operations

Much of the roadwork conducted on the watershed is routine and of a maintenance nature. Occasionally, however, new access roads are constructed or raised to higher standards to accommodate more intensive use, or new sources of gravel are developed to accomplish road work. In these cases, since the operations may result in habitat changes and possible impacts on water quality, wildlife, or cultural resources, the following procedure will be followed:

- Development of a plan showing the location to be affected, time sequence of removals and procedures to be employed.

- Consultation with DWSP Section Regional Directors, Natural Resources, Environmental Quality, and the DCR Archaeologist to determine that no significant impacts will occur to water quality, wildlife, or cultural resources.

Quabbin woods road

- Consultation with and completion of all necessary approvals from the Department of Environmental Protection, the Department of Fish and Game, Division of Fisheries and Wildlife (for information on both fisheries and rare species impacts), the local town Conservation Commission, and any other governmental entity with jurisdiction over the chosen site.

- Final approval from the Director of Natural Resources.

5.3.6.7 Beaver Populations in Long-term Planning for Access

Beaver populations in the state (and throughout the Northeast) continue to increase as the number of trappers and amount of human-caused mortality remain low. DWSP constantly deals with plugging of road culverts by beaver. In some situations, DWSP has successfully installed fences and water level control devices. These solutions, however, require continual maintenance and do not offer permanent relief. Further, fencing and/or water-level control devices may not be useful in all problem situations on the watersheds. Based on research in New York State, only 3% of sites are suitable for water-level control devices (Jensen et al., 1999). In situations where water level control devices are not an option, DWSP removes beaver either by trapping or shooting individual animals. Although this solution may offer immediate relief, the habitat and conditions that attracted beaver initially have not been altered and these sites are often re-colonized within a short period of time. DWSP recognizes the limitations of these various techniques and is working to develop a long-term plan for beaver management along roads.

Recent research suggests several management techniques to protect against beaver plugging of culverts. In 81% of sites examined in New York State, culvert size (area of inlet opening) was the major determinant of whether beaver plugged the pipe. The probability of a culvert being plugged increased with decreased culvert inlet opening area. Culverts with just 8 ft^2 of area were plugged 73% of the time, while culverts with 113 ft^2 of area were only plugged 7% of the time. The design of the culvert was also an important determinant of whether beaver altered the site. Pipe-arch culverts were less prone to being plugged by beaver than round culverts. Round culverts are more likely to channel the water and reduce the stream width, alter flow rates, and generate noise that attracts beaver. Unplugged pipe-arch culverts tended to retain the natural stream width. The width of the stream at plugged culverts was twice that of the culvert inlet opening (Jensen et al., 1999).

Both research and general observations suggest that beaver are more likely to occupy sites with lower gradient and smaller width streams (e.g., first or second order), as well as abundant woody vegetation. In areas with flat topography, the total amount of woody vegetation was the primary predictor of beaver presence in New York State (Jensen et al., 1999). Because each site can be evaluated for potential beaver habitat and the probability of culvert plugging, DWSP will incorporate beaver considerations in choosing stream crossing methods. In addition to evaluating watershed area, road classification, and stream size and gradient, DWSP personnel will also consider potential beaver habitat during replacement or installations of culverts. Culverts that may already be experiencing chronic beaver plugging will be prioritized for upgrading or replacement.

5.3.6.8 Management Guidelines for Beaver at Road Stream Crossings

DWSP will incorporate beaver management considerations into road and culvert planning when possible to reduce the probability of culverts being plugged by beavers. Recommended practices include the following:

- Replace existing smaller culvert pipes with larger, oversized pipes, where feasible and applicable.
- Use box or pipe-arch culverts, when possible, with a minimum inlet opening area of 18 ft^2 (smaller sizes are easily plugged).
- Size the culvert so that that the width of inlet is at least equal to or greater than the width of the stream. This will decrease noise and minimize the potential for altering flow.
- Avoid creating a depression or pond at the inlet when installing culverts, as these are attractive to beaver.

- Do not install multiple smaller pipes at a site instead of a larger pipe. It is not a workable alternative, as smaller pipes are much more likely to be plugged.

- Utilize other management options, as needed in situations where beaver have a history of plugging even large culverts (see section 5.4.4.1).

5.4 Wildlife Management

5.4.1 Assessment of Impacts of Planned Watershed Management Activities

The management activities described in this plan will have various impacts on the wildlife community at Quabbin. Most impacts on the wildlife community will be a result of habitat changes or modifications. The forest management approach described in this plan has landscape level affects, although individual changes at any given time will be very localized and small. While the management techniques used to reach the forest management goals will not be as dramatic as historic events (1938 hurricane, flooding of the reservoir), it is important to understand how these plans will affect the habitat and wildlife communities on the watershed.

The Division's primary long-term forest management goal is to establish and/or maintain a forest cover of diverse native tree species of many different age classes on a majority of its land holdings. This goal will primarily be accomplished through uneven-aged forest management. A 20-30 year cutting cycle will be used in most areas, and harvest will be through selection of individual trees or small groups (1/20-1/4 up to 2 acres). Uneven-aged management is the best technique for preserving individual trees of high wildlife value (dens, nests, roost, mast producers) (Payne and Bryant 1994). In addition, uneven-aged management increases vertical diversity. The end result is an even distribution of a low but constant population of understory plants and associated wildlife (Payne and Bryant 1994).

Meeting this primary objective will mean wildlife communities on Division land will be dominated by species adapted to forest conditions. Those species requiring early successional or open habitat will be less common and isolated to those areas where that type of habitat exists. Open and early successional habitat will be maintained on a small percentage of the Division's land, primarily associated with developed areas (dams, dikes), beaver impoundments, and existing fields. Forest wildlife communities should benefit the most from the Division's management plan.

5.4.2 Active Management to Enhance Habitat for Selected Wildlife Species

5.4.2.1 Bald Eagles

Quabbin Reservoir has played a critical role in the recovery and continued success of bald eagles in Massachusetts. From 1982 to 1988, 41 bald eagle chicks from Michigan and Canada were transported to Quabbin Reservoir and "hacked" or raised in artificial nesting platforms without human association. The efforts paid off in 1989 when 2 pairs at Quabbin produced the state's first successful breeding efforts. Eagles have bred successfully at Quabbin each year since, and anywhere from 3-5 pairs may breed annually.

Quabbin also serves as a vital wintering area for both resident and non-resident bald eagles. Because of its large size, Quabbin is often the last body of water in the state to freeze, providing open water habitat for eagles well into the winter. Annual mid-winter eagle counts have been conducted in Massachusetts since 1986 along 2 standardized routes (Quabbin Reservoir and Assawompsett Pond). Two additional routes (Connecticut River and Merrimack River) were added in 1995. In the last 20 years, Quabbin reservoir has consistently attracted more wintering eagles than any other area in the state. In fact, the